International Journal of Healthcare and Medical Sciences
ISSN(e): 2414-2999, ISSN(p): 2415-5233
Vol. 4, Issue. 4, pp: 42-48, 2018
URL: http://arpgweb.com/?ic=journal&journal=13&info=aims

Academic Research Publishing Group

Original Research Open Access

Design and Implementation of a New Wifi-Based Intelligent Alarm Device for the Elderly Bed-Wetting

Fen Lv
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Xu Liu
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Jing Gao
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Kun Fu
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Lin Miao
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Shun He
Department of Biomedical Engineering, Chongqing Medical University, Chongqing City, China

Longcong Chen*
Medical Information College, Chongqing Medical University, Chongqing City, China

Abstract

In order to meet the needs of the real-time monitoring for the elderly bed-wetting and night sweats, we designed a new alarm device. In this device, conductive wire array sensor, made by ourselves, is applied to sense body fluid and urine of the elderly. And the single-chip is used to simultaneously realize mobile phone alarm and bedside alarm. Furthermore, nurses and relatives can be informed in the first time by this device and make corresponding treatment. Therefore, the device has the advantages of low cost, convenient use, strong practicality and so on.

Keywords: Alarm device; Bed-wetting; Remote alarm; WiFi-based.

1. Introduction

Warning the Geriatric incontinence sensitively effectively on time for preventing the further physical damage is one of the most important geriatric nursing task that need to be solved urgently [1, 2]. Urinary incontinence can increase the probability of the psychological burden and the physical damage, affecting the quality of life and health of elder's physical and mental seriously. In recent years, more and more attention has been paid to the problem of urinary incontinence, and the elderly care has become a necessary content to improve the life quality [3-7]. So far the elderly care's hidden dangers is still existing, the pressure of nursing staff is also increasing year by year, and the economic pressure of the nursed home is also increasing year by year with the increasing of the nursing cost too Freundl and Dugan [8]. According to the actual survey, potentially reversible factors were strongly and independently associated with urinary continence. Failure to make all reasonable efforts to assess and to treat all these factors among frail elderly people should be considered one of the most important indicators of poor quality of care [4, 9-11]. For example, the rates of the people managed by an indwelling catheter or diapers widely varied among the nursing. If the diaper change is not timely, it is very easy to occur urinary dermatitis [2, 12-14]. It is suggested that adult diapers may not be the optimal treatment for urinary incontinence since they treat the symptom instead of the cause [15-17]. Therefore, investigation conclude that the urinary management in the elderly cared at home is insufficient and that standardization of nursing should be urgently needed to improve the quality in urinary management in the elderly [18-21]. In particular, it has been lasted 2 to 3 hours commonly, when to help the old man, lying in bed after urinary incontinence, to turn over, seeing or smelling the smell. So that the guardian can't be found in timely and disposed, making the elderly in a humid environment for a long time, and then it can lead to a variety of diseases [22]. Therefore, it is very meaningful to do a good job in bed patient's care for promoting the rehabilitation of the disease, prolong life, and improve the quality of life. But it is worth mentioning that nursing is directed at turning around reversible factors, preserving independence and dignity of the patient, and providing sensitive and empathetic care even if the problem is not completely remediable [11].

In order to solve the problem of elderly nursing in bed, there are many alarm devices for warning the urinary incontinence, which can be used to detect urine, such as humidity sensors, conductive cloth and so on [16, 17, 19,

*Corresponding Author

23]. Humidity sensor has been widely used in the detection of urine moisture. However, due to the influence of air humidity, the sensor has some disadvantages such as stability, accuracy and so on. The Japanese developed a new smart diaper, making of organic materials and plastic film. Although it has more advantages than the general sensor in the production cost and ease of use, its energy consumption problem must be explored further. We carve up a traditional conductive wire into array structure as sensor. And it is a kind of highly reusable sensor based on high conductive and immune to corrosion, which comprises two layers of strong water absorption layer, a protective layer of waterproof layer and two layer flexible conductive wire array. The sensor not only has the advantages of low cost and power consumption, but also is not easy to be disturbed by the external environment, and is favorable for prolonging the service life of the sensor. Hence, our sensor has more advantages in cost, anti-interference, energy consumption and can be reused. At the same time, along with the popularity of the Internet of Things, our device further combined with the wireless fidelity (WiFi) module, the alarm function is no longer confined to the bedside alarm, more remote alarm function, let not in custody staff can also receive the message.

This paper introduces a kind of cost-effective device about the detection of urinary incontinence by the array of conductive wires in a timely manner. When receiving signal of urinary incontinence, the microcomputer lit LED lights, buzzer alarm, and send alarm message to the phone by WiFi module. Then, the phone application (APP) displays the warning information in order to remind the guardian. Certainly, we can use this new method to establish a timely and effective, accurate and sensitive device for the detection of urinary incontinence in the elderly. And this provides a more effective care to prevent physical damage for the elderly bed-wetting and night sweats.

2. Material and Method

2.1. Hardware Platform

2.1.1. System Design

As shown in Fig.1, the hardware of this system mainly includes microcomputer unit, sensor unit and alarm unit, wireless communication unit, power supply unit. The sensor unit is used to collect the signal and output it to the microcomputer. The microcomputer unit is for receiving the signal, collected by the sensor unit, and judging bed-wetting or not. If bed-wetting, the microcomputer will activate the alarm unit. The alarm unit consists of LED lights and active buzzer, and it aim at realizing light and sound warm. The wireless communication unit mainly includes W-001 WiFi module and implements wireless communication with mobile phone. The power supply unit is composed of two dry batteries, and power the other units.

When bed-wetting happen, the microcomputer will receive the signal and active sound and light alarm. Meanwhile it will send the warm messages to the wireless WiFi module. Then the
wireless module sends them to mobile phone. Consequently, the local and remote warm are realized by our designed device. Next, we only describe the sensor, microprocessor and wireless module units in detail in this paper.

2.1.2. Sensor

The material of sensor is one kind of efficient electric and corrosion resistant static wire. The sensor is recycled. And it consists of two potent bibulous cloth layers, one waterproof cloth layer and two static wire array layers, shown in the figure 1. The two potent bibulous layers is more efficient and fast in absorbing urine or sweat, and the waterproof layer in the bottom stop urine flow down. The two layers of soft static wire array are among them, and static wire is a cross shape. The Fig.2 shows the sensor structure and Fig.3 presents the material object of it.

The circuit diagram of sensor is shown in the Fig.4. The sensor and resistors are in series connection linked to the power source, thus it shares some voltage. when the sensor is dry, the resistance of sensor is very huge, normally bigger than 500KΩ.But when the sensor is soaked by urine, the resistance of sensor will descend because of the electric conductivity of water . Then the collected signal converted by the A/D converter ,and microcomputer analyze the wet degree to judge bed-wetting or not.

2.1.3. The Microcomputer Unit

The microcomputer unit receives the signal sent by the sensor, and converts the collected signal by the A/D converter, then compares the converted signal with threshold, if bed-wetting, starting the alarm.Meanwhile the microcomputer send data to the wireless module through the pins of TXD and RXD. The alarm device uses high-performance and low power chip-MSP430F1222 as its main control part. MSP430F1222 features a powerful 16-bit RISC CPU, 16-bit registers, 10-bit A/D converter with integrated reference and data transfer controller (DTC) and fourteen or twenty-two I/O pins. In addition, it has built-in communication capability using asynchronous (UART) and synchronous (SPI) protocols.The architecture combined with five low power modes is optimized to achieve extended battery life in portable measurement applications.

2.1.4. The Wireless Module Unit

The wireless module basing on the RF module from TI's CC3200 chip which is integrated the function of transmission selects W-001 WiFi module of WeBee .The module supports STA and AP wireless networking. STA mode using W-001 module as a base station (STA) connects to a router to form a wireless network. AP mode, which uses the W-001 module as a wireless accessing point (AP)and allows other devices acting as STAs to connect it. You can see that we use a wireless module as AP mode in the demonstration picture of this article and this Module integrating transmission function can send the received data to the terminal monitoring equipment.

2.2. Software Platform

The software program design is divided into microcontroller program and the mobile phone one. In this paper, the microcontroller program is for a single chip processor, but the mobile phone program primarily introduces the APP one, the specific contents are as follows.

The microcontroller program is designed with C language and the ideas of software design are as follows. If the elderly do not urine in bed, the microcontroller will mainly stay in low-power mode in order to save power. If the bed-wetting, the sensor will produce a falling edge to triggered external interrupt. During the event of external interrupt, it will light the LED lamp and drive the buzzer, meanwhile, send data to the serial port.

Mobile phone program, APP, is realized with JAVA language, and Fig.5 is the APP warming interface we designed. When mobile phone receives the data sent by the WiFi module, a warning message will pop on the interface to remind the paramedic to deal the problem in a timely manner. At the same time, the different prompt messages of elderly life care will pop below the interface. There are three buttons at the bottom of the interface, they are Silence, Save and History. The button of Silence is to turn off the alarm of buzzer, avoiding affecting elderly to rest when the nursing staff failed to hear the sound of the alarm in time, this problem can be solved by closing the warning sound but left lights to remind the nursing staff. The button of Save is utmost to preserve the bed-wetting information. The button of History is to view all the previous bed-wetting information, including time, number and other information.

3. Simulation Experiment and Results

In order to test the performance of the device, we applied tap water to replace urine for simulating environment of urinary incontinence. When water infiltrate into sensor, we can saw the alarm light of device is shining and the alarm buzzer began pealing, as shown in Fig.6. In the meantime, APP on the long-range phone received the alarming signal and showed a corresponding message, shown in Fig.7.

The simulating result suggests that our designed device can effectively realize the local and remote warm for urinary incontinence, and may be applied in the actual.

4. Discussion and Conclusion

In this paper, we put forward a new intelligent alarm device for the elderly bed-wetting with low cost and power dissipation. Through the simulation test, it is verified that the stability and reliability of the device are high. In addition, our result also indicates that the device can effectively implement the real-time local and remote monitoring, and may effectively decrease the pain in patients with enuresis problems. Therefore, by taking advantage of our designed device, the probability of bedsore will reduce significantly, and the risk of colds and infection in bedridden patients will cut down markedly. At same time, caregivers can also be more at ease, they do not always check the bed-wetting situation, so as to reduce the workload and improve work efficiency. In addition, the device also has a certain significance of detection for severe night sweating.

When more than one device are extended to join together, it can realize systematic real-time monitoring and management of paraplegia or disability in elderly or patients in nursing homes and hospitals. So, it will greatly improve the life quality of the elderly and efficiency of nursing work.

In summary, the device uses a new sensor, an array of conductive wire, to sense urine and sweat with many features, such as WIFI for wireless transmission, wireless for internet access and so on. It can realize the remote and local real-time monitoring and alarm for the elderly in urinary incontinence and night sweats, and it is low in cost and convenient to be used. Therefore, the device has broad application prospects.

Illustration:

Figure-1. The system block diagram

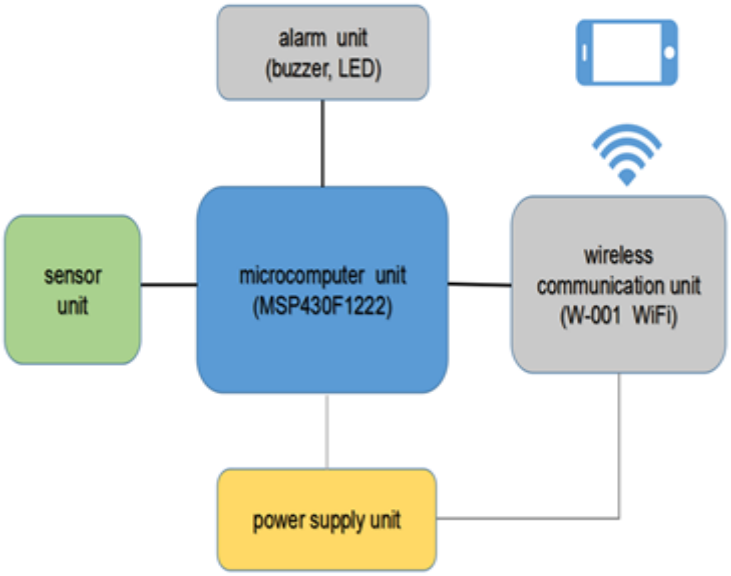

Figure-2. Sensor structure

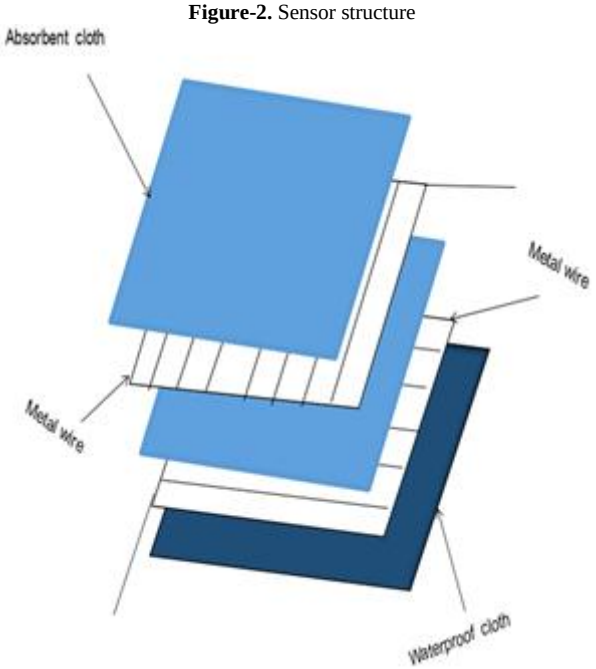

Figure-3. Sensor object

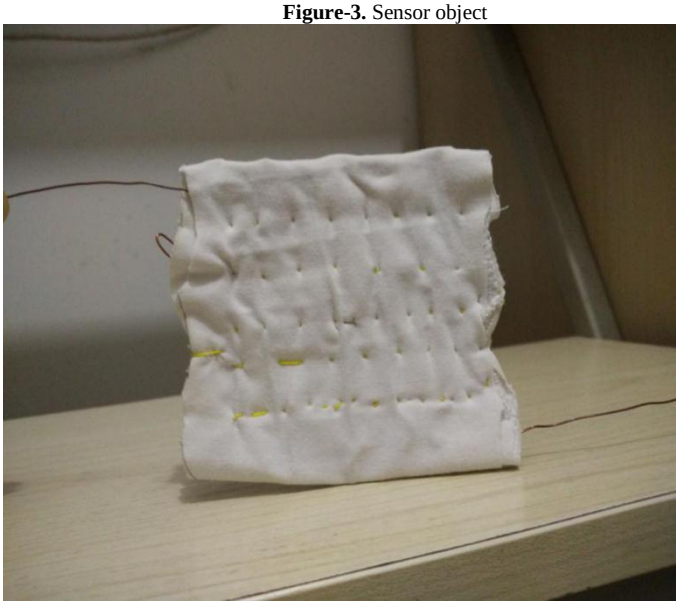

Figure-4. The circuit diagram of sensor

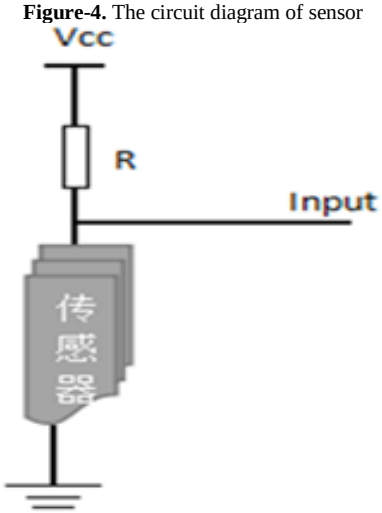

Figure-5. APP interface

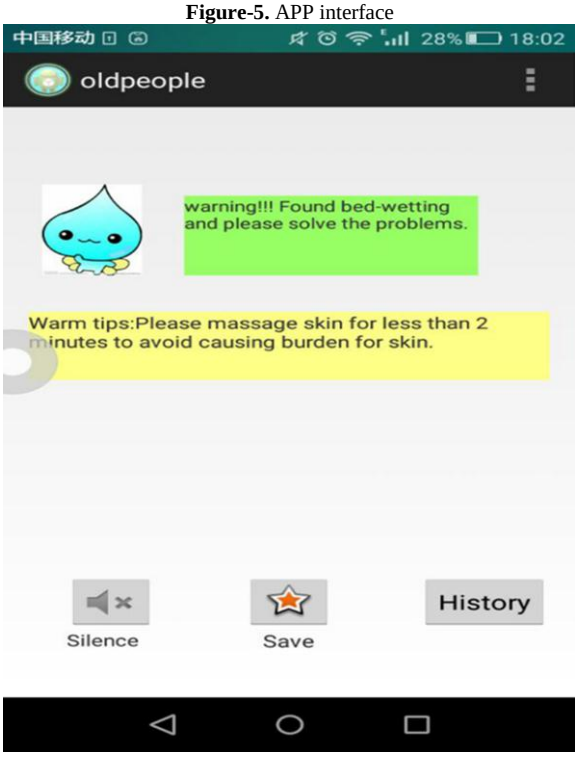

Figure-6. Illustration of simulation. device is shown in the picture. The yellow light shined when WiFi modules work well. The red light shined when TCP connection between WiFi modules and phone was successfully established.

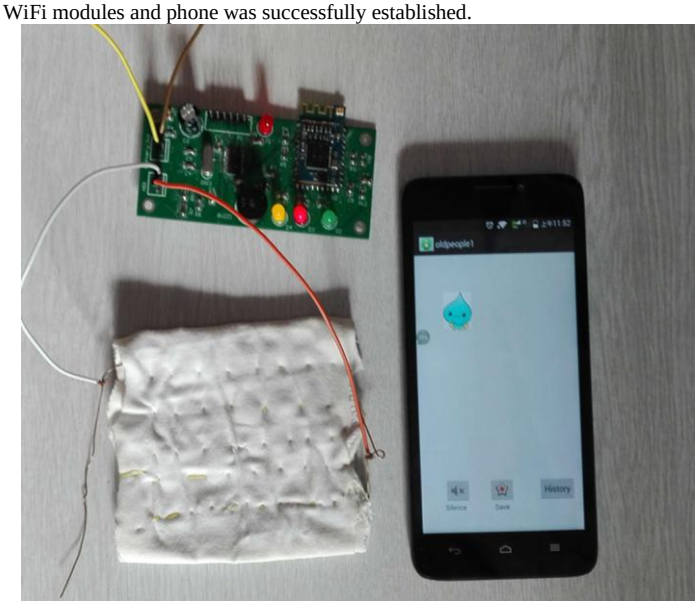

Figure-7. Illustration of alarm. How the alarm signal present is shown in the picture. The alarm light shined and alarm buzzer pealed. The long-range phone showed alarm message in the meantime.

Acknowledgments

This work was supported by Scientific Research and Innovation experiment fund for College students in Chongqing Medical University (201610).

References

[1] Johnson, T. N., Bernard, S. L., and Kincade, J. E., 2000. "Urinary incontinence and risk of death among community-living elderly people: results from the National Survey on Self-Care and Aging." *J Aging Health*, vol. 12, pp. 25-46.

[2] Du Moulin, M. F., Hamers, J. P., and Ambergen, A. W., 2009. "Urinary incontinence in older adults receiving home care diagnosis and strategies." *Scand J Caring Sci.*, vol. 23, pp. 222-230.

[3] Shimanouchi, S., Kamei, T., and Hayashi, M., 2000. "Home care for the frail elderly based on urinary incontinence level." *Public Health Nursing*, vol. 17, pp. 468-473.

[4] Landi, F., Cesari, M., and Russo, A., 2003. "Potentially reversible risk factors and urinary incontinence in frail older people living in community." *Age and Ageing*, vol. 32, pp. 194-199.

[5] Song, H. J. and Bae, J. M., 2007. "Prevalence of urinary incontinence and lower urinary tract symptoms for community-dwelling elderly 85 years of age and older." *J Wound Ostomy Continence Nurs*, vol. 34, pp. 535-541.

[6] Sorbye, L. W., Finne-Soveri, H., and Ljunggren, G., 2009. "Urinary incontinence and use of pads--clinical features and need for help in home care at 11 sites in Europe." *Scand J Caring Sci.*, vol. 23, pp. 33-44.

[7] Palmer, M. H., Czarapata, B. J., and Wells, T. J., 1997. "Urinary outcomes in older adults: research and clinical perspectives." *Urol Nurs*, vol. 17, pp. 2-9.

[8] Freundl, M. and Dugan, J., 1992. "Urinary incontinence in the elderly: knowledge and attitude of long-term care staff." *Geriatric Nursing*, vol. 13, pp. 70-75.

[9] Kang, H. and Hong, G. R., 2015. "Effect of muscle strength training on urinary incontinence and physical function: a randomized controlled trial in long-term care facilities." *Journal of Korean Academy of Nursing*, vol. 45, pp. 35-45.

[10] Teunissen, D. T., Stegeman, M. M., and Bor, H. H., 2015. "Treatment by a nurse practitioner in primary care improves the severity and impact of urinary incontinence in women." *An observational study. BMC Urology*, vol. 15, p. 51.

[11] Yap, P. and Tan, D., 2006. "Urinary incontinence in dementia - a practical approach." *Australian Family Physician*, vol. 35, pp. 237-241.

[12] Bliss, D. Z., Funk, T., and Jacobson, M., 2015. "Incidence and characteristics of incontinence-associated dermatitis in community-dwelling persons with fecal incontinence." *J Wound Ostomy Continence Nurs*, vol. 42, pp. 525-530.

[13] Sorbye, L. W., Finne-Soveri, H., and Ljunggren, G., 2005. "Indwelling catheter use in home care: elderly, aged 65+, in 11 different countries in Europe." *Age and Ageing*, vol. 34, pp. 377-381.

[14] Marron, K. R., Fillit, H., and Peskowitz, M., 1983. "The nonuse of urethral catheterization in the management of urinary incontinence in the teaching nursing home." *Journal of the American Geriatrics Society*, vol. 31, pp. 278-281.

[15] Kamei, T. F., Simanouchi, S., and Hayashi, M., 1996. "A study of endogenous-exogenous factors in urinary incontinence and home care nursing of the elderly at home." *Kango Kenkyu*, vol. 29, pp. 399-412.

[16] Starer, P. and Libow, L. S., 1985. "Obscuring urinary incontinence. Diapering of the elderly." *Journal of the American Geriatrics Society*, vol. 33, pp. 842-846.

[17] Belmin, J., Hervias, Y., and Avellano, E., 1993. "Reliability of sampling urine from disposable diapers in elderly incontinent women." *Journal of the American Geriatrics Society*, vol. 41, pp. 1182-1186.

[18] Schussler, S. and Lohrmann, C., 2015. "Change in care dependency and nursing care problems in nursing home residents with and without dementia: A 2-year panel study." *Plos One*, vol. 10, p. 141653.

[19] Boiko, S., 1997. "Diapers and diaper rashes." *Dermatol Nurs.*, vol. 9, pp. 33-39.

[20] Borrie, M. J., Bawden, M., and Speechley, M., 2002. "Interventions led by nurse continence advisers in the management of urinary incontinence: a randomized controlled trial." *CMAJ.*, vol. 166, pp. 1267-1273.

[21] Cheater, F. M., 1993. "Retrospective document survey: identification, assessment and management of urinary incontinence in medical and care of the elderly wards." *Journal of Advanced Nursing*, vol. 18, pp. 1734-1746.

[22] Gotoh, M., Yoshikawa, Y., and Hattori, R., 2002. "A fact-finding inquiry on urinary management of the elderly in home care." *Hinyokika Kiyo*, vol. 48, pp. 653-658.

[23] Nakrem, S., Vinsnes, A. G., and Harkless, G. E., 2009. "Nursing sensitive quality indicators for nursing home care: international review of literature, policy and practice." *International Journal of Nursing Studies*, vol. 46 pp. 848-857.